Grants Project

Homestake Mining Company of California

Thomas Wohlford
Closure Manager

7 September 2017

ATTN: Mr. Matthew Meyer
Project Manager
Materials Decommissioning Branch
Division of Decommissioning, Uranium Recovery and Waste Programs
Office of Nuclear Materials Safety and Safeguards
U.S. Nuclear Regulatory Commission
Mail Stop: T-8F5
Washington, DC 20555

ATTN: Mr. Sairam Appaji
Region VI Superfund Division
1445 Ross Avenue, Suite 1200
6SF-LP
Dallas, TX 75202-2733

ATTN: Mr. Kurt Vollbrecht
Ground Water Quality Bureau
New Mexico Environment Department
PO Box 5469
Santa Fe, NM 87502-5469

ATTN: Mr. Christopher Burrus
New Mexico Office of the State Engineer
5550 San Antonio Drive, N.E.
Albuquerque, NM 87109

RE: San Andres Glorieta Aquifer Well 943 (B-28-S-329), Monitoring Well and Pump Test Work Plan

Dear Sirs:

The New Mexico Environment Department (NMED) has requested a work plan for the construction of a monitoring well (943M) to be completed in the San Andres-Glorieta (SAG) aquifer near existing SAG fresh water supply well 943 (B-28-S-329). SAG well 943 is one of four active fresh water supply wells located on Homestake Mining Company's (HMC) Grants Reclamation Project site. Following the installation of this monitoring well, the NMED is requesting a pump test of SAG well 943 to evaluate the hydrologic connectivity between nearby Chinle and/or Alluvial wells, as well as hydrologic influence with adjacent SAG wells.

The updated request by the NMED, dated August 8, 2017, is attached as Attachment A. Well 943 ceased pumping on May 18, 2017 (Item 1) and this is HMC's response to Item 1 of the above referenced NMED letter. The NMED August 8, 2017 letter item numbers are placed in parenthesis where the HMC's response has been added in this letter. Well 943M has been permitted by the New Mexico Office of State Engineer (OSE) B-28-POD-1341 and is attached as Attachment B (Item 2.b). This draft work plan includes the details for installation of the SAG aquifer monitoring well as well as the pump test to be performed using SAG well 943 and nearby wells.

SAG Monitoring Well 943M Work Plan:

SAG aquifer monitoring well 943M is proposed to be drilled approximately 200 feet northwest (Item 2.a) of SAG fresh water supply well 943 which will locate this well on the upgradient side of well 943 (see **Figure 1** for proposed location). Monitoring well 943M is proposed to be completed in the upper portion of the San Andres limestone similar to all other SAG wells in this area, except well 943 which has a final completion that extends into the Glorieta sandstone. The base of the alluvium is expected to be near 50 feet below the land surface based on the log of 943 (see Attachment C and Figure 2).

Eighty feet of 12-inch diameter surface casing is proposed to be installed into the top of the Chinle shale which underlies the alluvium in this area. The Upper Chinle has been eroded away and does not exist in this area underlying the alluvium. **Figure 1** shows the location of the Upper Chinle subcrop to the east of well 943 which also shows the western limit of the Upper Chinle sandstone near well 943. The surface casing will be installed a minimum of 10 feet into the Chinle Shale. **Figure 2** presents a completion schematic for well 943M showing the 12-inch diameter surface casing. The annular space around the outside of the casing will be grouted with neat cement from the bottom of the casing to the land surface. The proposed cement type is API Class B (or equivalent) and the volume of cement is estimated to be 305 gallons (41 cubic feet). The grout seal will be allowed to cure for 24 hours prior to initiating further drilling operations.

The top of the Middle and Lower Chinle sandstones are expected to be encountered at approximately 221 and 372 feet respectively below grade surface (ft. bgs) in this area while the base of these sandstones are expected at 271 and 395 feet. The top of the San Andres Glorieta limestone should be encountered near a depth of 700 feet below the land surface.

The well is proposed to be drilled with air rotary drilling until it is no longer effective then switch to mud rotary (Item 2.d) with a minimum final borehole diameter of 10.6 inches and a casing depth of 740 feet below grade (ft. bg). The well cutting disposal will be according to HMC's SOP 22 (Item 2.f) which is in Attachment D. Steel casing (Item 2.c) with a wall thickness of 0.28 inches and an inside diameter of 6.1 inches is proposed for well 943M. The steel casing is proposed because it is more resistant to heat generated during cementing of the annulus than PVC casing. Centering guides should be placed every 40 feet on the casing. The bottom of the casing will be set at 740 ft. bg. The annular space around the outside of the casing will be grouted with a neat cement (Item 2.e) from the bottom of the casing to the land surface. The proposed cement type is API Class B (or equivalent) and the volume of cement is estimated to be 2076 gallons (277.5 cubic feet). The grout seal will be allowed to cure for a minimum of 48 hours prior to initiating further drilling operations.

An open borehole with a diameter of 5.5 inches will be drilled into the SAG aquifer from 740 to 800 feet below grade with 4.0-inch diameter stainless steel screen (No. 30 slot size) with a minimum of 5 percent open area installed in the open borehole interval of the well. The stainless steel screen is not proposed to be sand packed because the SAG is consolidated and a filter pack is not needed. The screen should maintain access to the SAG aquifer should borehole collapse occur in the future.

The well will be developed to remove any drilling sediment /mud in the casing. The well is to be developed by air lifting until it does not produce any sediment or mud from the drilling program.

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The water from the development program will be disposed of according to HMC's SOP 22 (see Attachment D Item 2.f). The San Andres aquifer is not expected to be contaminated at this location and the uranium concentration should be less than 0.03 mg/l. A sample from the early well development will be analyzed by HMC's KPA for uranium to determine if the water needs to be transported to EP-1.

HMC will install a Grundfos 22SQ15C-200 or equivalent pump to a depth of 180 feet (or deeper, dependent upon static hydraulic head level) after the well is developed, and will pump well 943M for at least two hours at a rate of approximately 25 gallons per minute (gpm). If field water quality parameters of pH, temperature, electrical conductivity and oxidation-reduction potential (ORP) are not stable after two hours of pumping the test should be continued until parameters are stable. A water quality sample will be collected from the well after parameters have stabilized. The sample will be submitted for the analysis of Se, U, U-234, U-235, U-238, Mo, SO4, Cl, total dissolved solids (TDS), NO3, Ra-226, Ra-228, Th-230, Ca, Mg, Na, K, HCO3, F, PO4 and V (Item 2.g). HMC will add well 943M to its quarterly monitoring for Se, U, Mo, SO4, Cl, TDS, and NO3 (Item 2.i).

A pressure transducer/datalogger will be installed in the monitoring well for collection of water level data, shortly after well development. This pressure transducer will be used for permanent water level data measurements and will be set to collect daily water level measurements and more frequent measurements (i.e. every minute) during the pumping test (Item 2.h).

A report documenting the SAG monitoring well details, including volumes of materials used, composition of materials, drilling method, and aquifer (alluvial and/or Chinle) encountered, shall be submitted to the NMED within 30 days of well completion (Item 2). The analytical results from the well sampling event will also be submitted after their completion.

Well 943 Pump Test Work Plan:

The 943 Pump Test Work Plan has been updated (Item 3). SAG fresh water well 943 is proposed to be pumped at a rate of approximately 300 gpm (Item 3.f) while water levels in well 943 and surrounding monitor wells are measured (see **Table 1** and **Figure 1** (Item 3.a) for completion details and locations). The pump that is currently in 943 will be replaced with a slightly large pump capable of producing 300 gpm. The higher flowrate will produce larger drawdowns in any connecting aquifers in the vicinity of the test. The water from the pumping test will be directed into the current discharge line for injection into the alluvial and Middle Chinle aquifers at the Off-Site South plume area (Item 3.b). Pressure transducers will be used to measure the water levels in well 943, 943M and surrounding wells with the transducer/dataloggers programmed to record water levels at one minute intervals (Item 3.c).

Table 1. SAG Well 943 and Surrounding Well Completion Details

Well I.D.	Total Depth	Screen/Borehole Opening/Setting	Aquifer
943	978	703-978	SAG
943M	975	705-975	SAG
822	980	790-875	SAG
986	467	420-467	SAG
CW37	150	100-150	Lower Chinle
V1	270	230-270	Lower Chinle
546	160	130-160	Middle Chinle
546R	270	210-270	Middle Chinle

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821	260	-	Middle Chinle
CW15	134.6	73-133	Middle Chinle
CW30	251.5	219-249	Middle Chinle
CW75	190	150-190	Middle Chinle
CW76	270	230-270	Middle Chinle
CW77	280	240-280	Middle Chinle
557	65	45-65	Alluvial
844	75	35-75	Alluvial
845	65	45-65	Alluvial

Note: Ernest Molina irrigation wells are 546 and 546R.

The Upper Chinle aquifer does not extend to the well 943 location (see Figure 1 for Upper Chinle western limit) and therefore Upper Chinle wells will not be monitored during the test. If possible, water levels will be monitored with transducer/data loggers and water levels will be recorded at one minute intervals in the monitoring wells. If possible, the transducers will be installed one week before the pumping phase to allow monitoring for existing trends.

The pump test will be conducted for one week (7 days). Background water level measurements will be collected for 7 days prior to commencement of testing. Following completion of the pump test, water levels will be measured for another 7 days (Item 3.c).

Water quality samples from pumping well 943 will be collected for laboratory analysis prior to the test and after pumping approximately 5, 20 and 60 minutes and at the end of each day during the pump test and will be analyzed for Se, U, Mo, SO4, Cl, TDS and NO3 (Item 3.e). The sample taken prior to the pump test will occur a few days before the start of the pump test to limit any potential drawdown effects it may have on the pump test itself. Field parameters for these samples will be pH, temperature, specific conductivity and oxidation-reduction potential.

Water quality samples wells 845, 943, CW76 and V1 will be collected for laboratory analysis prior to the test and after the pumping phase of the test and will be analyzed for Se, U, U-234, U-235, U-238, Mo, SO4, Cl, TDS, NO3, Ra-226, Ra-228, Th-230, Ca, Mg, Na, K, HCO3, F, PO4 and V (Item 3.d). Field parameters for these samples will be pH, temperature, specific conductivity and oxidation-reduction potential. The samples after the pumping phase of the test will be collected toward the end of the seven days of recovery monitoring when pumping of these wells should not affect the conclusions of the pump test.

Thank you for your time and attention on this matter. If you or anyone on your staff has any questions, please contact me at the Grants office at 505.287.4456, extension 34, or call me directly on my cell phone at 505.290.2187.

Respectfully,

Thomas D. Wohlford

Thomas Wohlford
Closure Manager
Homestake Mining Company of California
Office: 505.287.4456 x34 | Cell: 505.290.2187

Copy To:

B. Tsosie, DOE, Grand Junction, Colorado (electronic copy)
M. McCarthy, Barrick, Salt Lake City, Utah (electronic copy)
H. Burns, Barrick, Toronto, Ontario (electronic copy)
C. Burton, Barrick, Toronto, Ontario (electronic copy)
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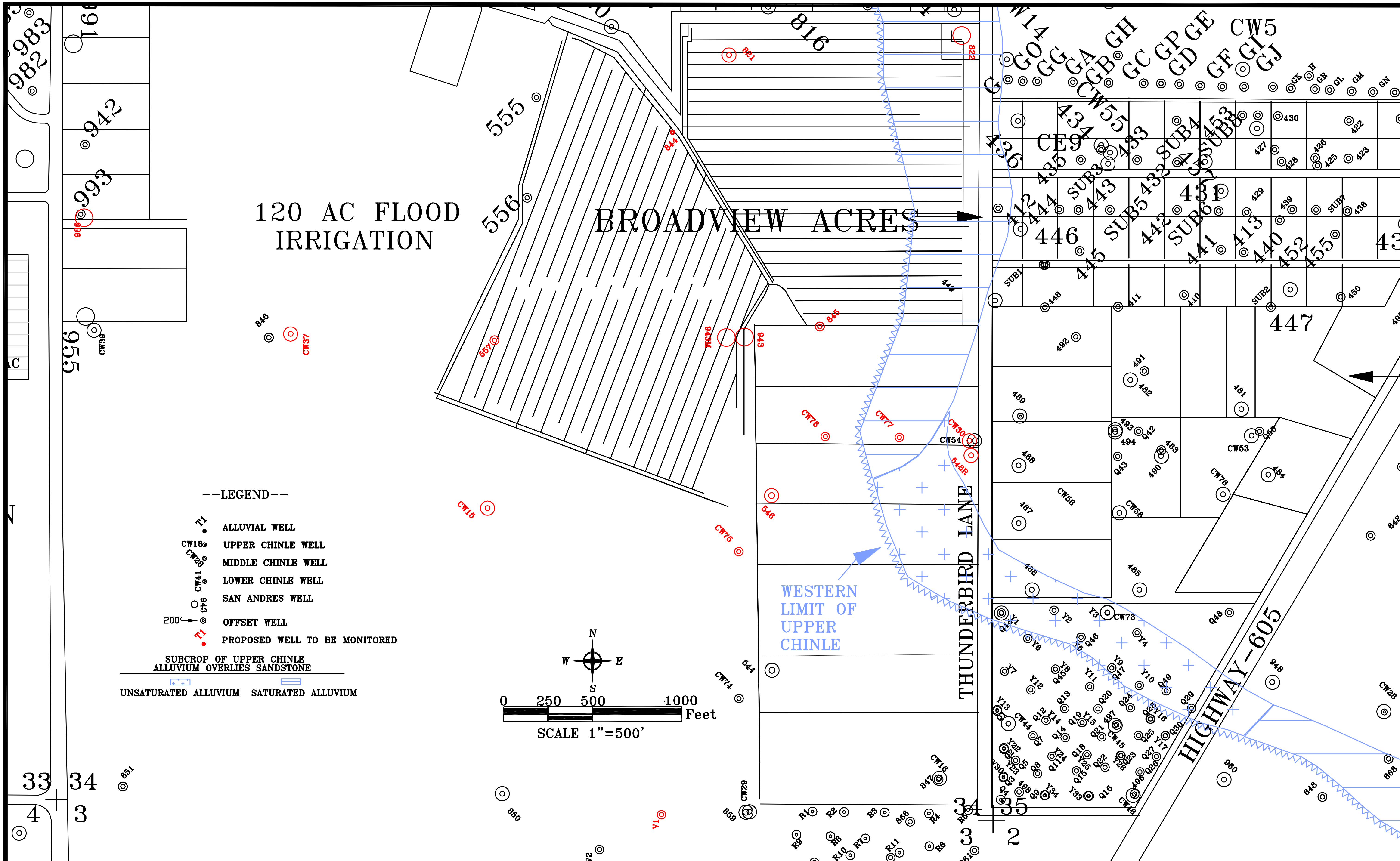

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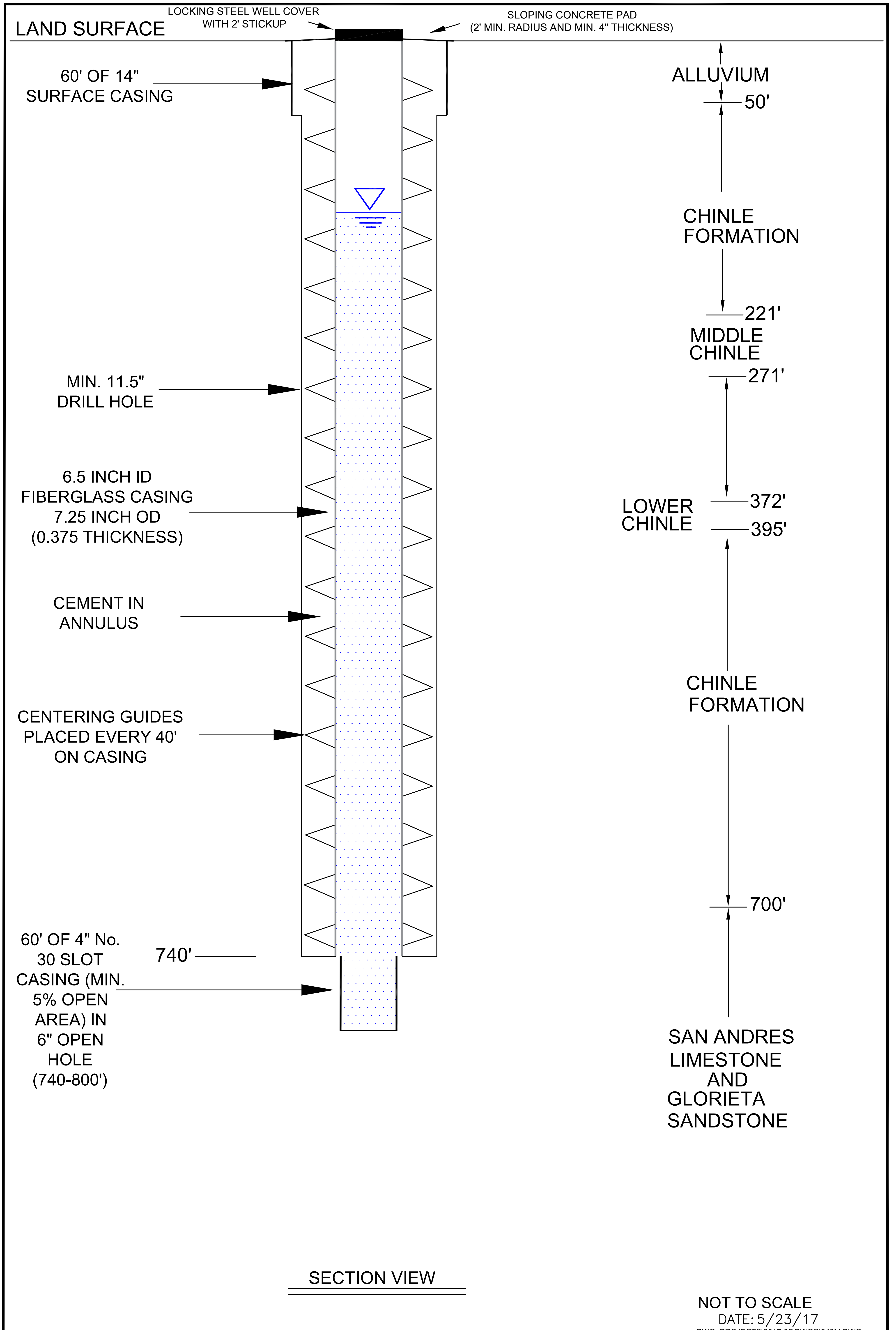
DATE: 5/17/17

FIGURE 1. LOCATION OF MONITORING WELL 943M AND PLANNED MONITORING WELLS IN 943 PUMP TEST



HOMESTAKE MINING COMPANY

FIGURE 2. WELL 943M COMPLETION SCHEMATIC

Attachment A

N.M.E.D Letter

SUSANA MARTINEZ
Governor

JOHN A. SANCHEZ
Lieutenant Governor

NEW MEXICO
ENVIRONMENT DEPARTMENT

Harold Runnels Building
1190 South St. Francis Drive (87505)
P.O. Box 5469, Santa Fe, New Mexico 87502-5469
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BUTCH TONGATE
Cabinet Secretary

J.C. BORREGO
Deputy Secretary

CERTIFIED MAIL – RETURN RECEIPT REQUESTED

August 8, 2017

Thomas Wohlford, Closure Manager
Homestake Mining Company of California
P.O. Box 98
Grants, NM 87020

RE: Homestake Mining Company of California (HMC), Condition 21, Discharge Permit 200 (DP-200), Revised Response to *San Andres Glorieta Well 943 (B-28-S-329), Draft Monitoring Well and Pump Test Work Plan* and *Potential Sources to San Andres Glorieta Aquifer Well 943 (B-28-S-329), Condition 4*

Dear Mr. Wohlford:

On July 27 and 28, 2017, the New Mexico Environment Department, Mining Environmental Compliance Section (NMED), NM Office of the State Engineer (OSE) and HMC met via two telephone conference calls to discuss a response letter issued to HMC from NMED on July 21, 2017. From these calls, NMED is issuing this revised response in references to the submitted 'work plan' to install monitoring well 943M, the submitted 'pump test work plan' for Well 943, and to explain potential sources and pathways of contamination detected in Well 943. NMED approves the work plans as submitted and explanation of potential pathways of contamination detected in Well 943 subject to the following comments. The text in italics is from the NMED May 10, 2017 letter to HMC, followed by NMED response and revised response in bold and bold italics text, respectively.

1. *The Agencies request that HMC cease use of Well 943 as a water source, effective immediately.*

   HMC did not indicate that it had ceased the use of Well 943. Please provide confirmation of the cessation of use of Well 943 within 30 days from the date of this letter.

   - ***HMC indicated it discontinued the use of Well 943 in May 2017. Within 30 days from the date of this letter, please submit a confirmation letter, to NMED, stating the exact date use of Well 943 ceased.***

2. *HMC shall install a monitoring well in the immediate area of Well 943 and into the SAG to properly evaluate ground water quality. Within 30 days from the date of this letter, a 'Work Plan' shall be submitted, for approval, to NMED and OSE concurrently describing the well location, well construction, and the drilling method and materials to be used. Monitoring well construction shall be performed in accordance with NMED, March 2011, "Monitoring well construction and abandonment guidelines (rev. 1.1)" (attached) and the regulations in 19.27.4 NMAC that have been issued by the New Mexico Office of the State Engineer, unless an alternative method is approved. In addition, the Work Plan shall include a proposal for water quality sampling, including collection of water quality samples immediately following well development and stabilization.*

   NMED approves the 'Well 943M Work Plan' subject to the following comments. Please respond within 30 days from the date of this letter. ***Within 30 days from the date of this letter, please submit a revised work plan agreeing to and incorporating the following comments.***

   a. **Well 943M is proposed to be installed 100 feet west of Well 943. NMED requests that the well be placed 200 feet northwest of Well 943. This will ensure that the prior use of Well 943 does not influence Well 943M.**
      - ***HMC has agreed to this location change.***
   b. **An Artesian Well Plan of Operation work plan shall be submitted to OSE as Well 943M will be drilled into artesian conditions. Please submit a revised Artesian Well Plan of Operation (NMAC 19.27.4.31) to OSE and NMED for review.**
      - ***HMC has agreed to submit a revised Artesian Well Plan of Operation to OSE and NMED based on the content of this letter.***
   c. **Fiberglass casing is not approved by NMED. Carbon steel casing is approved as this material was previously installed in existing SAG wells within the HMC reclamation project and eliminates any adsorbing and leaching issues (desorption/dissolution) of inorganic and organic constituents within the fiberglass casing. Steel casing also alleviates any concerns of heat generating during the cementing of the annulus as stated in work plan. The steel casing shall be installed from the land surface to the proposed total depth with a slotted well screen and sand filter pack. All requirements shall be**

incorporated into the revised Artesian Well Plan of Operation mentioned above.

- ***HMC has agreed to install a carbon steel casing and submit a revised Artesian Well Plan of Operation to OSE and NMED based on the content of this letter.***

d. **Air rotary or sonic drilling is preferred method to assist in detecting the alluvial and Chinle aquifers.**
   - ***HMC has agreed to use air rotary until it is no longer effective then switch to mud rotary to complete the remainder of the well to its final depth.***

e. **Annular seal around the outside of the casing shall be grouted with 100% cement from the bottom to the land surface. No bentonite shall be added to the casing annular seal.**
   - ***HMC has agreed to this request.***

f. **All water generated during the drilling and development of Well 943M shall be contained on site, not discharged to the ground surface, and properly disposed. Please identify the method used to dispose of water from the drilling and development of Well 943M.**
   - ***HMC agreed to submit a Standard Operating Procedure (SOP) to dispose of the development water, sediment and cuttings for review and approval by NMED and U.S. Nuclear Regulatory Commission (NRC). The SOP shall be submitted with and incorporated into the revised Well 943M Work Plan.***

g. **Field water quality parameters monitored during the development of Well 943M are appropriate. Water quality samples collected after well stability shall be as follows: calcium, magnesium, sodium, potassium, bicarbonate, fluoride, phosphate, total dissolved solids, selenium, uranium^{234}, uranium^{235}, uranium^{238}, molybdenum, sulfate, chloride, thorium^{230}, radium^{226} and radium^{228}, ammonium, total kjeldahl nitrogen, and nitrate and nitrite-nitrogen.**
   - ***HMC has agreed to monitor field parameters during the development of Well 943M and to collect one water quality sample from Well 943M following development of Well 943M for the constituents listed above. NMED and HMC also agree that the following constituents of concern are to be removed from the above list to be analyzed following the development of Well 943M: ammonium, total kjeldahl nitrogen and nitrite-nitrogen.***

h. **The use of pressure transducer/dataloggers to monitoring water levels is appropriate and approved by NMED. NMED request that the pressure transducer/dataloggers be installed immediately after development of Well 943M to begin collection of water level data.**
   - ***HMC has agreed to this request.***

i. **NMED agrees that Well 943M should be added to the quarterly samples routine for HMC and analyzed for the constituents of concern as listed in Item 'g' listed above.**

- ***NMED and HMC agree that future quarterly water quality sampling of Well 943M shall be analyzed for the follow Site Contaminates of Concern: selenium, uranium, molybdenum, sulfate, chloride, total dissolved solids and nitrate-nitrogen.***

A report documenting well details, including volumes of materials used, composition of materials, drilling method, and aquifers (alluvial and/or Chinle) encountered, shall be submitted to NMED within 30 days of well completion. [20.6.2.3107 NMAC]

Information to be submitted within 30 days of well completion. ***The submittal of well completion report within 30 days of well completion has not changed.***

3. *Upon completion of the monitoring well installation and sampling as required in Condition 2 listed above, HMC shall conduct a pump test to evaluate hydrologic connectivity between adjacent Chinle or Alluvial wells, as well as hydrologic influence with adjacent SAG wells. Within 60 days from the date of this letter, a 'Pump Test Work Plan' shall be submitted for approval to NMED and OSE concurrently describing the methods and materials to be used for the pump test.*

NMED approves the 'Well 943 Pump Test Work Plan' subject to the following comments. Please respond within 30 days from the date of this letter. ***Within 30 days from the date of this letter, please submit a revised work plan agreeing to and incorporating the following comments.***

a. **Please submit a revised Figure 1 showing the location of all wells to be monitored during the pump test. All wells within the immediate area of the pump test shall be clearly identified with well identifications and symbols to facilitate NMED review (11" x 17").**
    - ***HMC has agreed to submit a revised figure.***
b. **Water from the pump test shall be transported to the reverse osmosis and/or zeolite water treatment system for treatment. As stated in the May 10, 2017 letter and listed above, Item no. 1, HMC shall cease using Well 943 as water source effective immediately. Therefore, all water generated from the pump test of Well 943 shall be transported to and treated at the Reverse Osmosis and/or Zeolite water treatment system and shall not be directed into discharge lines for injection. Please identify which treatment system(s) will be utilized.**
    - ***NMED, NRC and HMC agree that waters generated from the Well 943 pump test can be pumped into the existing discharge line for injection into the alluvial and Middle Chinle aquifers at the Off-site South plume area.***
c. **HMC shall install pressure transducer/dataloggers in all wells proposed to be monitored at least one week prior to the pumping phase to monitor water level trends. Readings shall be recorded at a minimum of one minute intervals.**

NMED agrees that water levels should be measured for an additional 7 days following the conclusion of the pump test on one minute intervals.

- *HMC has agreed to install pressure transducer/dataloggers and measure water levels as stated above.*

d. **Water quality samples shall be collected and analyzed from Well 943 for the following constituents of concern prior to beginning of the pump test (Day 0) and at the completion of the pump test (Day 8): calcium, magnesium, sodium, potassium, bicarbonate, fluoride, phosphate, total dissolved solids, selenium, uranium^{234}, uranium^{235}, uranium^{238}, molybdenum, sulfate, chloride, thorium^{230}, radium^{226} and radium^{228}, vanadium, ammonium, total kjeldahl nitrogen, and nitrate and nitrite-nitrogen.**

- *The above comment shall be replaced with the agreed upon comment as follows: Water quality samples shall be collected and analyzed from SAG Well 943, alluvial well 845, Middle Chinle well CW76, and Lower Chinle well V1 for the following dissolved constituents prior to beginning of the pump test and at the completion of the pump test: calcium, magnesium, sodium, potassium, bicarbonate, fluoride, phosphate, total dissolved solids, selenium, uranium, uranium^{234}, uranium^{235}, uranium^{238}, molybdenum, sulfate, chloride, thorium^{230}, radium^{226} and radium^{228}, vanadium, and nitrate-nitrogen. Field parameters, including pH, temperature, specific conductance, and oxidation-reduction potential, will be measured at the time of sampling.*

e. **Water quality samples shall be collected from Well 943 immediately prior to initiation of pumping, and at approximately 5, 20, and 60 minutes after the beginning of the pumping on the first day of the 7-day pump test, and at the end of each work day for the remainder of the pump test. Water samples shall be analyzed for the following dissolved constituents: total dissolved solids, selenium, uranium, molybdenum, sulfate, chloride, and nitrate-nitrogen.**

- *The above comment shall be replaced with the agreed upon comment as following: Water quality samples shall be collected from Well 943 immediately prior to initiation of pumping, and at approximately 5, 20, and 60 minutes after the beginning of the pumping on the first day of the 7-day pump test; and at the end of each work day for the remainder of the pump test. Water samples shall be analyzed for the following dissolved constituents: total dissolved solids, selenium, uranium, molybdenum, sulfate, chloride, and nitrate-nitrogen. Field parameters, including pH, temperature, specific conductance, and oxidation-reduction potential, will be measured at the time of sampling.*

f. ***HMC stated that Well 943 pumping rate will be reduced to approximately 150 gallons per minute rather than 300 gallons per minute as stated in the proposed work plan. This reduction in pumping rate is due to the size of the pump in Well 943.***

4. *Within 30 days from the date of this letter, HMC shall submit an explanation of the potential source(s) and pathway(s) of contamination detected in Well 943.*

   NMED agrees that contaminants entering the Well 943 are most likely to enter the SAG via the well annulus from a pathway of higher concentration. However, the requirements to perform a pumping test on Well 943 and the installation of Well 943M should help in finding the true cause. *No changes were made to the above statement.*

5. *Based on evaluation of data collected from the monitoring well pump test and initial sampling event, the Agencies will determine, in consultation with HMC when Well 943 will be plugged and abandoned.*

   Determination of Well 943 plugging and abandonment still pending. *No changes were made to the above statement.*

If you have any questions, please contact Bill Pearson at (505) 827-0602 or by e-mail at william.pearson@state.nm.us

Sincerely,

Kurt Vollbrecht, Program Manager
Mining Environmental Compliance Section
Ground Water Quality Bureau

E-Mailed Copies:
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Bill Pearson, NMED, (william.pearson@state.nm.us)
Kurt Vollbrecht, NMED, (kurt.vollbrecht@state.nm.us)

Attachment B

WR-07 for well 943M

File No.

NEW MEXICO OFFICE OF THE STATE ENGINEER

WR-07 APPLICATION FOR PERMIT TO DRILL

A WELL WITH NO WATER RIGHT

(check applicable box):

For fees, see State Engineer website: http://www.ose.state.nm.us/

Purpose:

- ☐ Exploratory Well (Pump test)
- ☒ Monitoring Well
- ☐ Pollution Control And/Or Recovery
- ☐ Construction Site/Public Works Dewatering
- ☐ Mine Dewatering
- ☐ Ground Source Heat Pump
- ☐ Other(Describe):

A separate permit will be required to apply water to beneficial use regardless if use is consumptive or nonconsumptive.

☐ Temporary Request - Requested Start Date: Requested End Date:

Plugging Plan of Operations Submitted? ☐ Yes ☒ No

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1. APPLICANT(S)

Name: Homestake Mining Company of California	Name:
Contact or Agent: check here if Agent ☐ Thomas Wohlford	Contact or Agent: check here if Agent ☐
Mailing Address: P.O. Box 98	Mailing Address:
City: Grants	City:
State: New Mexico Zip Code: 87020	State: Zip Code:
Phone: (505)287-4456 ☐ Home ☒ Cell Phone (Work):	Phone: ☐ Home ☐ Cell Phone (Work):
E-mail (optional): TWOHLFORD@BARRICK.COM	E-mail (optional):

FOR OSE INTERNAL USE

Application for Permit, Form WR-07, Rev 11/17/16

File No.:	Trn. No.:	Receipt No.:
Trans Description (optional):		
Sub-Basin:	PCW/LOG Due Date:	

2. WELL(S) Describe the well(s) applicable to this application.

Location **Required: Coordinate location must be reported in NM State Plane (NAD 83), UTM (NAD 83), or Latitude/Longitude (Lat/Long - WGS84).**
District II (Roswell) and District VII (Cimarron) customers, provide a PLSS location in addition to above.

☐ NM State Plane (NAD83) (Feet)
☐ NM West Zone
☐ NM East Zone
☐ NM Central Zone

☐ UTM (NAD83) (Meters)
☐ Zone 12N
☐ Zone 13N

☒ Lat/Long (WGS84) (to the nearest 1/10th of second)

Well Number (if known):	X or Easting or Longitude:	Y or Northing or Latitude:	Provide if known: -Public Land Survey System (PLSS) (*Quarters or Halves , Section, Township, Range)* OR - Hydrographic Survey Map & Tract; OR - Lot, Block & Subdivision; OR - Land Grant Name
943M	35°13'30.1"	107°52'37.1"	NWSE Section 34, T12N, R10W

NOTE: If more well locations need to be described, complete form WR-08 (Attachment 1 – POD Descriptions)
Additional well descriptions are attached: ☐ **Yes** ☒ **No** **If yes, how many**_______

Other description relating well to common landmarks, streets, or other:

Well is on land owned by: Homestake Mining Company of California

Well Information: **NOTE: If more than one (1) well needs to be described, provide attachment.** **Attached?** ☐ **Yes** ☐ **No**
If yes, how many_______

Approximate depth of well (feet): 800	Outside diameter of well casing (inches): 7.25
Driller Name: Will be sent to OSE after bidding	Driller License Number:

3. ADDITIONAL STATEMENTS OR EXPLANATIONS

This is a San Andres aquifer monitoring well to be located 100 feet West of B-28 POD329 (HMC 943) and likely needed though 2024.

FOR OSE INTERNAL USE

File No.:	Trn No.:

4. SPECIFIC REQUIREMENTS: The applicant must include the following, as applicable to each well type. Please check the appropriate boxes, to indicate the information has been included and/or attached to this application:

Exploratory: ☐ Include a description of any proposed pump test, if applicable.	**Pollution Control and/or Recovery:** ☐ Include a plan for pollution control/recovery, that includes the following: ☐ A description of the need for the pollution control or recovery operation. ☐ The estimated maximum period of time for completion of the operation. ☐ The annual diversion amount. ☐ The annual consumptive use amount. ☐ The maximum amount of water to be diverted and injected for the duration of the operation. ☐ The method and place of discharge. ☐ The method of measurement of water produced and discharged. ☐ The source of water to be injected. ☐ The method of measurement of water injected. ☐ The characteristics of the aquifer. ☐ The method of determining the resulting annual consumptive use of water and depletion from any related stream system. ☐ Proof of any permit required from the New Mexico Environment Department. ☐ An access agreement if the applicant is not the owner of the land on which the pollution plume control or recovery well is to be located.	**Construction De-Watering:** ☐ Include a description of the proposed dewatering operation, ☐ The estimated duration of the operation, ☐ The maximum amount of water to be diverted, ☐ A description of the need for the dewatering operation, and, ☐ A description of how the diverted water will be disposed of.	**Mine De-Watering:** ☐ Include a plan for pollution control/recovery, that includes the following: ☐ A description of the need for mine dewatering. ☐ The estimated maximum period of time for completion of the operation. ☐ The source(s) of the water to be diverted. ☐ The geohydrologic characteristics of the aquifer(s). ☐ The maximum amount of water to be diverted per annum. ☐ The maximum amount of water to be diverted for the duration of the operation. ☐ The quality of the water. ☐ The method of measurement of water diverted. ☐ The recharge of water to the aquifer. ☐ Description of the estimated area of hydrologic effect of the project. ☐ The method and place of discharge. ☐ An estimation of the effects on surface water rights and underground water rights from the mine dewatering project. ☐ A description of the methods employed to estimate effects on surface water rights and underground water rights. ☐ Information on existing wells, rivers, springs, and wetlands within the area of hydrologic effect.
Monitoring: ☒ Include the reason for the monitoring well, and, ☒ The duration of the planned monitoring.		**Ground Source Heat Pump:** ☐ Include a description of the geothermal heat exchange project, ☐ The number of boreholes for the completed project and required depths. ☐ The time frame for constructing the geothermal heat exchange project, and, ☐ The duration of the project. ☐ Preliminary surveys, design data, and additional information shall be included to provide all essential facts relating to the request.	

ACKNOWLEDGEMENT

I, We (name of applicant(s)), Thomas Wohlford

Print Name(s)

affirm that the foregoing statements are true to the best of (my, our) knowledge and belief.

Thomas N. Wohlford

Applicant Signature   Applicant Signature

ACTION OF THE STATE ENGINEER

This application is:

☐ approved   ☐ partially approved   ☐ denied

provided it is not exercised to the detriment of any others having existing rights, and is not contrary to the conservation of water in New Mexico nor detrimental to the public welfare and further subject to the attached conditions of approval.

Witness my hand and seal this ________ day of ________________ 20 ______ , for the State Engineer,

_______________________________________, State Engineer

By: ______________________________   ______________________________

Signature   Print

Title: ______________________________

Print

FOR OSE INTERNAL USE

File No.:	Trn No.:

Attachment C

Well 943 Completion Details and Lithology

Revised June 1972

STATE ENGINEER OFFICE

WELL RECORD

Section 1. GENERAL INFORMATION

(A) Owner of well Homestake Mining Company of Ca. Owner's Well No. 0943
Street or Post Office Address P.O. Box 98
City and State Grants, NM 87020

Well was drilled under Permit No. unknown and is located in the:

a. NE ¼ NW ¼ SE ¼ ____ ¼ of Section 34 Township 12N Range 10W N.M.P.M.

b. Tract No. ____ of Map No. ____ of the ____

c. Lot No. ____ of Block No. ____ of the ____
Subdivision, recorded in ____ County.

d. X= ____ feet, Y= ____ feet, N.M. Coordinate System ____ Zone in the ____ Grant.

(B) Drilling Contractor unknown License No. unknown

Address unknown

Drilling Began ____ Completed 1/1/1980 Type tools ____ Size of hole ____ in.

Elevation of land surface or ____ at well is ____ ft. Total depth of well 978 ft.

Completed well is ☐ shallow ☐ artesian. Depth to water upon completion of well 107.07 ft.

Section 2. PRINCIPAL WATER-BEARING STRATA

Depth in Feet From	Depth in Feet To	Thickness in Feet	Description of Water-Bearing Formation	Estimated Yield (gallons per minute)
743	978	235	Sandy Limestone	

Section 3. RECORD OF CASING

Diameter (inches)	Pounds per foot	Threads per in.	Depth in Feet Top	Depth in Feet Bottom	Length (feet)	Type of Shoe	Perforations From	Perforations To
18" steel			0	304				
16"			255	408				
13" 10"			347 460	510 703		open hole	703	978

Section 4. RECORD OF MUDDING AND CEMENTING

Depth in Feet From	Depth in Feet To	Hole Diameter	Sacks of Mud	Cubic Feet of Cement	Method of Placement

Section 5. PLUGGING RECORD

Plugging Contractor ____
Address ____
Plugging Method ____
Date Well Plugged ____
Plugging approved by:

____
State Engineer Representative

No.	Depth in Feet Top	Depth in Feet Bottom	Cubic Feet of Cement
1			
2			
3			
4			

FOR USE OF STATE ENGINEER ONLY

Date Received

Quad ____ FWL ____ FSL ____

File No. ____ Use ____ Location No. ____

Section 6. LOG [illegible]E

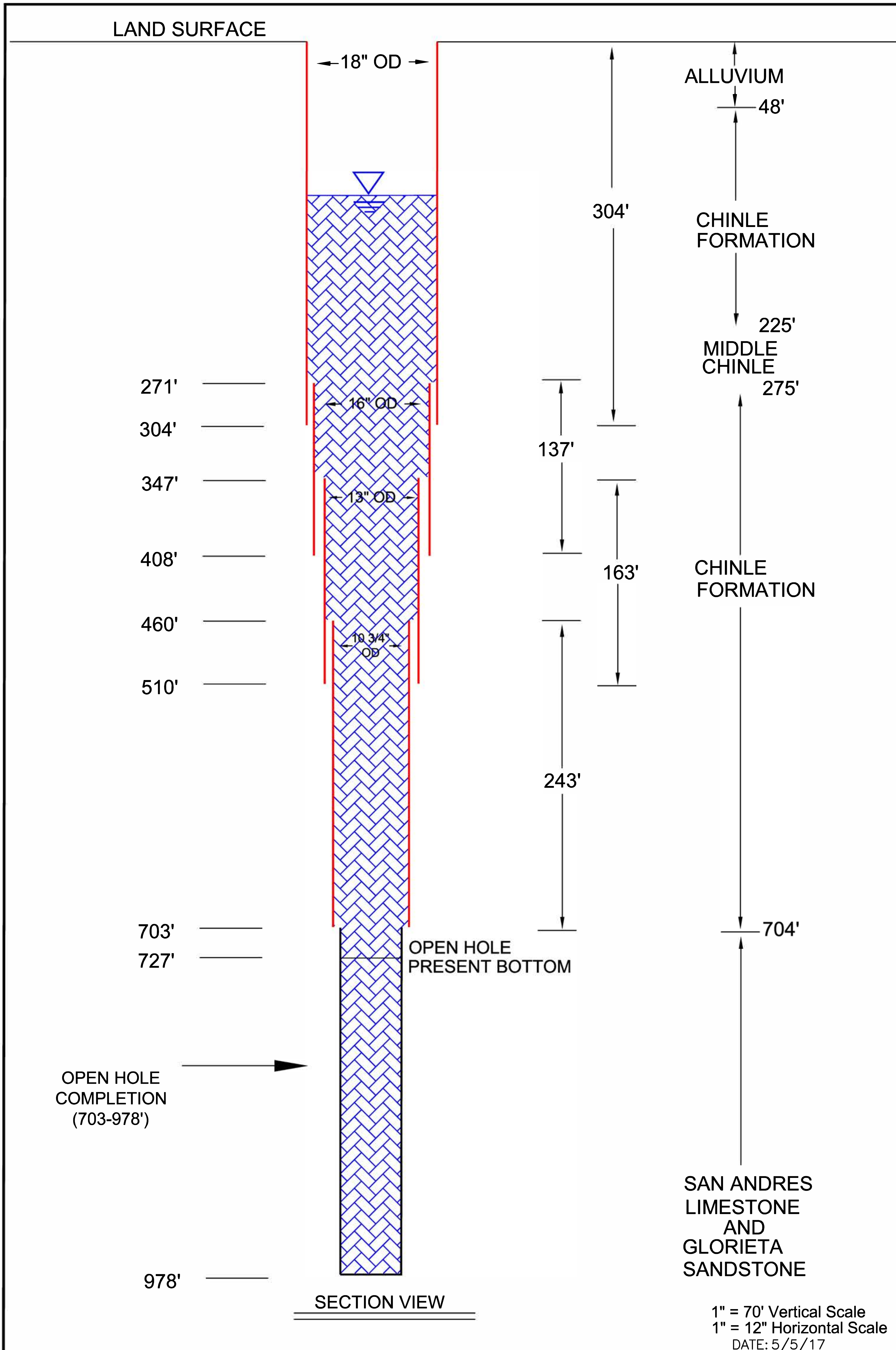
Depth in Feet		Thickness in Feet	Color and Type of Material Encountered
From	To		
0	10		surface soil
10	18		black sand
18	26		yellow clay
26	48		sand
48	66		shale
66	100		red clay
100	131		brown shale
131	145		blue shale
145	157		sandstone
157	177		blue shale
177	186		sandstone
186	225		blue shale
225	275		sand
275	304		red shale
304	325		sand gravel
325	395		blue shale
395	397		sand gravel
397	408		hard lime
408	441		blue shale
441	451		brown sandy shale
468	473		red shale
473	512		broken shale and conglomerate
512	575		red shale
575	653		gray shale
653	668		red shale
668	705		gray shale
705	712		blue shale
712	724		red shale streaks of sand stone
724	743		blue shally sand
743	848		sandy lime
848	851		yellow sand
851	870		fine white water sand
870	874		sand and iron pyrites
874	~~8~~78 9		sand (hard)

Section 7. REMARKS AND ADDITIONAL INFORMATION

The undersigned hereby certifies that, to the best of his knowledge and belief, the foregoing is a true and correct record of the above described hole.

Driller

INSTRUCTIONS: This form should be executed in triplicate, preferably typewritten, and submitted to the appropriate district office of the State Engineer. All sections, except Section 5, shall be answered as completely and accurately as possible when any well is drilled, repaired or deepened. When this form is used as a plugging record, only Section 1(a) and Section 5 need be completed.



HOMESTAKE MINING COMPANY

WELL 943 COMPLETION DETAILS

Attachment D

SOP-22 Well Installation and Development

SOP 22 – ***Procedure for Drilling and Well Installation***

[Potentially Applicable Regulatory Basis or Bases: SUA-1471, Conditions 23 and 24].

OBJECTIVES

The objective of this standard operating procedure (SOP) is to provide the methods to be used for the installation and development of groundwater wells, and to provide standardized reporting formats for documentation of data. This SOP has been specifically designed with the objective of installing and developing wells.

SCOPE AND APPLICABILITY

This procedure is intended for use for the installation, development, and documentation of monitoring, collection, injection and water supply wells.

Specific well design and installation procedures depend on project-specific objectives and subsurface conditions, and should be discussed in project-specific planning documents. The following aspects will need to be determined when planning a well installation:

- Borehole drilling method
- Construction materials
- Well depth
- Screen length
- Well construction materials
- Location, thickness, and composition of annular seals
- Well completion and protection requirements.

Groundwater well installation and development will be performed in accordance with applicable New Mexico State regulations, this SOP and the project-specific planning documents. Drilling methods employed to pilot the borehole for well installation will be dependent on the physical nature of the subsurface materials (unconsolidated materials and/or consolidated materials) at the site. The drilling contractor shall be a licensed water well driller, in accordance with local and state requirements.

Health and Safety

All workers on the Grants Reclamation Site must wear Level D Personal Protective Equipment (PPE) when outside the main office enclosure. Level D PPE consists of hard hat, high-visibility vest or clothing, long-sleeved shirt, pants, steel-toed work boots, hearing (in high decibel noise areas) and eye protection. Potential physical and chemical hazards will need to be addressed when planning well installation. A health and safety plan (HASP) that addresses known and anticipated field conditions must be prepared prior to field work and be followed during well installation. On the Grants Reclamation Project, the primary radiological constituents of concern of uranium, thorium-230, radium-226 and radium-228 may be encountered especially if drilling on top of the Large Tailings Pile (LTP). A Radiation Safety Work Permit (RSWP) may be applicable if tailings will be encountered. The Radiation Safety Officer (RSO) must review the proposed scope of work to decide how to deal with contaminated drill cuttings and whether a RSWP is required. All staff must wear proper Personnel Protective Equipment (PPE) such as long-sleeved shirts, work pants and gloves to avoid skin contact with tailings. The drill cuttings must be kept moist to prevent wind-blown dust exposure.

RESPONSIBILITES

The *Project Manager* is responsible for ensuring that the project involving well installation is properly planned and executed, and that safety of personnel is provided from chemical and physical hazards associated with drilling and well installation activities.

The *Radiation Safety Officer* is responsible for ensuring that the project involving potential radiological hazards is safe to perform and determining what applicable mitigation is required to maintain ALARA (As Low As Reasonably Achievable) standards.

The *Field Geologist or Engineer* is responsible for directly overseeing the construction and installation of the wells by the driller, ensuring that the well installation specifications defined in the project-specific planning documents are followed, and that pertinent data are recorded on appropriate forms and in the field notebook. Well construction and boring completion will be conducted under the supervision of an appropriately-qualified and registered person as defined by local regulations.

The *Site Safety Officer (SSO)*, typically the field geologist or engineer, is responsible for overseeing the health and safety of employees and for stopping work if necessary to fix unsafe conditions observed in the field. If a subcontracted firm conducts installation and documentation activities, then the firm will designate an SSO.

WELL PERMIT

Prior to initiating any drilling operation on the Grants Reclamation Site, a well permit must be obtained from the Office of State Engineer (OSE). Typically a small fee such as $5 is required to be submitted for each well to be installed. This permit must be obtained before scheduling the work.

ARTESIAN WELL PLAN

For any well to be drilled and installed in a confined aquifer in the State of New Mexico, the OSE is requiring completion and submittal of an Artesian Well Plan with the well permit application. The Artesian Well Plan requires that all surface aquifers, such as the alluvial aquifer at the Grants site, be cased off first with surface casing prior to proceeding to drill into the lower confined aquifer(s). The Artesian Well Plan identifies the type of casing and other materials to be used in the well installation operations.

REQUIRED MATERIALS

Many materials are required for successfully completing the installation and development of wells. The drilling Subcontractor often supplies much of the material. However, the field personnel should be aware of what is required to conduct the work so they have their own supplies (if needed) and can provide complete Subcontractor oversight. The following is a general list of materials that are needed for performing the tasks outlined in this SOP.

Geologist

- Hand lens for mineral and grain size identification
- Health and Safety supplies (e.g., steel-toed boots, gloves, hard hat, etc.)
- Lithologic Logs and Well Completion forms
- Logbook
- Logging assistance tools (e.g., grain-size charts, color charts)
- Measuring tapes (both long weighted cloth type and small measuring tape, preferably marked in tenths and hundredths of a foot)

Drilling Subcontractor

- Drilling equipment (depends upon the type of drilling, e.g., drill stem, auger, generators, compressors, steam cleaners, etc.)
- Well drilling supplies (drilling mud)
- Decontamination pad construction supplies
- Well construction supplies (screen, well casing, sand pack, bentonite chips, bentonite/cement mixture, water).
- Health and safety records required for working on-site
- Ancillary support vehicles

METHODS

The borehole diameter must be a minimum of four (4) inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs and grout seals. All boreholes will be cleared for shallow obstructions by following the SOP for Utility Clearance. In New Mexico, it is required to place an 811 call for underground utility mark-out. After placing the call, the caller typically receives a response from *all* utility companies in the area *whether they have a service in the area or not*.

Drilling Methods

Several drilling methods are available for use in creating a borehole for well installation. These methods include hollow-stem, air rotary, mud rotary, and cable tool, among others. The drilling method selected will be based on the physical properties of the subsurface materials.

Hollow-Stem Auger Methods

Hollow-stem auger uses continuous-flight hollow-stem augers with a bit on the bottom to drill and maintain an open borehole. The continuous-flight auger drives the drill cuttings to the surface as drilling progresses. The walls of the auger minimize the amount of unconsolidated materials entering into the space inside the casing. Intact soil samples are collected by pounding a steel split-spoon sampler ahead of the auger. The well casing, filter pack and seal are installed inside the auger. The auger is removed slightly ahead of backfilling as filter pack and grout are added. Careful recording of the amount of each material used should be recorded in the field logbook.

Mud Rotary Methods

Mud rotary drilling uses drilling fluids or synthetic gels to circulate drill cuttings to the surface. Drilling fluid will consist of water mixed with bentonite. Powdered bentonite or an approved equivalent will be used as an additive in the drilling fluid. Bentonite will be mixed into the drilling fluid using a mud mixer and a portable mud tank. Drilling fluid density and viscosity will be maintained at appropriate levels for the various lithology encountered and in accordance with material specifications.

A shale-shaker and de-sanding system will be used to maintain the density and viscosity of the drilling fluid. Sand content will be minimized to the degree possible by maintaining no greater than four (4) percent (%) sand by mud volume.

If water or other drilling fluids have been introduced into the borehole during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. Also, an attempt should be made to recover the quantity of fluid or water introduced by flushing the borehole before well installation and/or by pumping the well during development.

Air Drilling Methods

The following are descriptions of air rotary, “down-the-hole”, Air Rotary Casing Hammer (ARCH) method, and dual-wall reverse-circulation air rotary methods. Air rotary uses air as a primary means of transporting drill cuttings to the surface. A large compressor provides filtered air that is piped to the swivel hose connected to the top of the Kelly bushing or drill pipe. The air, forced down the drill pipe, escapes through small ports at the bottom of the drill bit, thereby lifting the cuttings and cooling the bit. The cuttings are blown out the top of the hole and are collected at the surface in a cyclone unit and a container or pit. Injection of a small volume of clean water into the air system controls dust and lowers the temperature of the air so that the swivel is cooled. Air drilling is effective in semi-consolidated or consolidated materials.

A second direct rotary method using air is called the “down-the-hole” or percussion down-hole hammer drilling system. A pneumatic drill operated at the end of the drill pipe rapidly strikes the rock while the drill pipe is slowly rotated. The percussive effect is similar to the blows delivered by a cable tool bit. Cuttings are removed continuously by the air used to drive the hammer.

A third direct air rotary method called the ARCH method is used where an outer steel casing is advanced slightly behind the drill bit. The drill bit reams material in front of the casing and then the casing is advanced with a pneumatic hammer down the hole to prevent hole collapse. Cuttings are collected in a tube system that conveys them into a cyclone at the surface.

The dual-wall reverse-circulation air rotary method uses flush-jointed, double-wall pipe in which the air moves by reverse circulation. The airflow is contained between the two walls of the dual-wall pipe and only contacts the walls of the borehole near the bit. Dual-wall pipe can be driven into place in loosely-consolidated materials by a pile hammer as a drive bit is cutting the formation. Downhole air hammers and tricone bits can also be used to cut the formation. The air lifts the cuttings to the surface through the inner pipe. Dual-wall methods can be applied in consolidated and unconsolidated formations.

Rotosonic Drilling

Rotosonic is a core drilling method that employs simultaneous high-frequency vibration and low-speed rotational motion along with downward pressure to advance the core barrel without use of drilling fluid or air. The core barrel can generally advance from five to 20 feet at one time, depending on the length of the core barrel. The drill cuttings are brought to the surface by removal of the entire core barrel from the borehole and the cuttings are vibrated out of the barrel. If required for logging purposes, the cuttings are collected in plastic sleeves. An outer casing is generally washed-down with water to stabilize the borehole from collapse and heaving sand. The outer casing prevents cross-contamination and formation mixing. The advantage of rotosonic core drilling is that no drilling fluids or muds are required to bring the cuttings to the surface and the aquifer is less likely to be contaminated by the drilling method.

Borehole logging

Boreholes will be logged using cuttings and samples collected during drilling activities. Soil or rock samples will be collected as described in the SOP for Soil Sampling (SOP-23). Cuttings, soil and rock samples will be described at the frequency presented in the project-specific planning documents following the procedures outlined in SOP for Soil and Rock Descriptions (SOP-24).

After drilling has been completed, the field geologist/engineer will measure the total open depth of the borehole with a weighted, calibrated tape measure and document the depth. The field geologist will then collaborate with the supervising geologist by reviewing lithologic units encountered, water levels, if any, and other logged information to determine the well construction details.

Boreholes/well locations should be clearly designated in the field notes using notes and a hand-sketched layout, and should include the following information:

- Measurements of each boring/sample point relative to fixed objects (building, structures, etc),
- Boring/sample location with the identification number noted,
- North arrow or other compass directional indicator, and
- Other essential site features and/or investigation features (underground storage tanks, piping, above-ground tanks, etc.).

WELL CONSTRUCTION PROCEDURES

Wells will be constructed in accordance with state and local agency requirements, and will include at a minimum the following materials:

- Borehole backfill for over-drilled boreholes prior to well installation,
- Well casing and screen
- Filter pack materials
- Well sealing materials (e.g., bentonite pellets, cement, powdered bentonite), and
- Surface seals and materials for well surface completion (e.g., concrete, protective steel casing, steel posts, surface boxes).

A discussion of these materials and how they are used is provided in more detail in the following sections.

Backfilling

If backfilling the borehole to the appropriate well installation depth is necessary, neat cement, bentonite grout, bentonite pellets or filter pack sand may be used. The backfill material selected for use will depend on site conditions, lithology, and project-specific requirements. Most often, the borehole requires complete sealing with lower layers, so neat cement, bentonite grout, or bentonite pellets are used. The setup time should be a minimum of 48 hours for neat cement and 24 hours for bentonite grout and bentonite pellets prior to beginning well construction. Field personnel should remeasure and verify that the bottom of the borehole is exactly where it should be set before proceeding with well construction. The necessary setup times may be reduced if manufacturer-approved additives are mixed with the grout to accelerate the cure time.

If neat cement or bentonite grout is used, a tremie pipe will be required to place the grout in the bottom of the hole. Grouting the borehole may be difficult to accomplish, if the portion of the borehole to be grouted is significantly lower than the groundwater level. Provisions will be necessary to support the screen and riser pipe to prevent sinking into the grout. Care will be taken to frequently measure the total borehole depth when adding grout to the bottom of the hole. Grout should have thickened to a hardened state before proceeding. The thickness of the grout will be calculated based on depth readings and recorded. If a well has been backfilled too much, it may require reaming to clear out the overfilled material.

Depending upon the lithology, some distance should be planned between the fill in a borehole and the bottom of the screened interval. Unless this distance would result in a breach of a confining layer, or the well screen requires setting directly on the impermeable zone due to site requirements, the bottom of the well screen should be set at a maximum of six inches above the top of any backfill. The distance between the top of fill and the bottom of the well screen should be filled with a fine sand buffer.

Bentonite pellets should be carefully dropped into the borehole to minimize the risk of pellets sticking to the side of the borehole when dropped through a water column. Pellets are generally easier to place than bentonite chips because pellets do not hydrate as quickly; hence pellets are the preferred method for small backfill jobs where significant confining zones have not been breached.

Well Casing and Screen

The well will consist of factory-sealed commercially-available well screen and casing. Well screens and casing will typically be constructed of polyvinyl chloride (PVC), a type of plastic, but may also be constructed of stainless-steel or Teflon® depending on subsurface conditions or other project requirements. Stainless-steel casing shall meet one of the following standards: American Society For Testing Materials (ASTM) A-53-93A or B, A-589-93, or American Petroleum Institute 5L, March 1982 Edition to conform to the minimum standards given in Table A of that document.

Plastic casing and liners shall meet the requirements of ASTM Standard F480-94 and the National Sanitation Foundation (NSF) International Standard Number 14-1990, Plastic Piping System Components and Related Materials. Evidence of compliance shall be included in the current NSF listing, display of the NSF seal on each section of casing, and marking the casing in accordance with the requirements of ASTM Standard F-480-94. Plastic well casing and liners must be Standard Dimension Ratio (SDR)-rated and conform to the minimum requirements given in Table B of the above-referenced document.

Well screens shall be constructed of non-corrosive and non-reactive material. Well screens shall be permanently joined to the well casing and shall be centered in the borehole. The anticipated length of screen and the reasoning behind choosing the length of screen will be determined when developing the project-specific planning documents. Modification can be made in the field, but will be done in consultation with the PM, or their designee such as the Project Technical Manager or Responsible Geologist.

Screen slot type and size will be dependent on the sand pack material and the aquifer formation material. Casing will be connected by flush-threads or coupled-joints, and will be completed with a bottom cap. A collection sump may be installed below the screen and will vary in length depending on lithology and project needs. The collection sump and bottom cap will be connected to the well screen by flush-threaded or coupled-joints. Plastic casing must have threaded joints and O-ring seals. Solvent, glue, or anti-seize compounds will not be used on the joints. With deep wells (greater than approximately 100 feet below grade), centralizers should be used to keep the well casing plumb and straight in the borehole. Centralizers should be placed at approximately 20-foot intervals in the screen interval and 40-foot intervals throughout the blank casing interval.

For water table wells, well screens should be placed such that some of the screened interval is above the water table, and some section is below the water table. This allows for seasonal water level fluctuations. The amount of split should be determined by the lead responsible geologist and be based upon local conditions.

Casing and screen (well string) must be clean, free of rust, grease, oil or contaminants, and be composed of materials that will not affect the quality of the water sample. All casing shall be water-tight. The casing shall be centered in the borehole, be free of any obstructions and allow sampling devices to be lowered into the well. The well string shall be hung in the borehole during installation so that the well is sufficiently plumbed and straight after completion.

Filter Pack

Wells installed in unconsolidated material will be constructed with filter packs. When used, the filter pack will be the only material in contact with the well screen. The filter pack will consist of sand or gravel. The sand or gravel used for filter pack material shall be sized to match the screen slot size and the surrounding lithology to prevent subsurface materials from penetrating through the sand or filter pack, and preventing the sand or filter pack from entering the well. Sizing of the filter pack material is often conducted using sieve analysis and following interpretative procedures outlined in Driscoll (1986). The sand or gravel shall be free of clay, dust, and organic material. Crushed limestone, dolomite, or any material containing clay or any other material that will adversely affect the performance of the monitoring well shall not be used as filter pack. The filter pack will extend a maximum of six inches below the bottom of the screen to two to three feet above the top of screen. The filter pack material may be placed in the well by pouring the sand into the open borehole, or tremied into place depending upon site-specific criteria. However, in all cases, filter pack material should be added carefully with continuous measurements by the field geologist to prevent bridging of the filter pack material.

Groundwater wells completed into competent bedrock material are often not completed with filter pack material, and can be completed as an open hole over the screened interval. Completion in this manner should be carefully considered and approved by regulatory agencies prior to field mobilization.

The well will be gently bailed and surged with a bailer and surge block or air lifting after the filter pack has been added to the borehole and before the seal is placed in the annular space. A surge block consists of a rubber or leather and metal plunger attached to a rod or pipe of sufficient length to reach the bottom of the screen. Surging should be maintained for at least five minutes and the entire length of saturated screen will be surged to help settle the filter pack. The top of the filter pack will need to be gauged after surging and additional filter pack material may need to be added if settling has occurred.

Sometimes project-specific requirements may identify that a transition sand be emplaced above the main filter pack. This transition sand is usually much smaller grain size than the filter pack, and is emplaced to provide added protection that grout invasion into the filter pack will not occur when deep wells (greater than 200 feet deep) are installed. Transition sands can be emplaced up to 10 or 20 feet above the regular sand pack interval. An alternative to transition sands is to use additional well seal material such as bentonite pellets.

Well Sealing Material

The wells will have an annular space seal that extends from the top of the filter pack to the ground surface. The annular sealing material above the filter pack will prevent the migration of fluids from the surface and between aquifers. Sealing material will be chemically compatible with anticipated contaminants. Hydrated bentonite chips or pellets are typically used as an annular seal directly above the filter pack. The annular seal should be a minimum of three feet-thick unless site-specific requirements dictate otherwise. For example, as mentioned above, deep wells may require additional sealant material (10 to 20 feet thick versus three feet) between the sand pack and cement to prevent grout invasion into the filter pack interval. Cement and/or bentonite grout or bentonite chips are typically used as annular fill above the seal. Above the sealant material, a bentonite grout mixture is often used as an annular fill to complete the well installation to within two feet of the ground surface. Grout will be emplaced using a tremie pipe so that the grout fills the annular space from the bottom to the ground surface without allowing air pockets to form in the filled zone.

Surface Completions

Above-Grade or Monument Surface Well Head Completion

With above-grade well completions, the well casing will extend to two to three feet above the ground surface. A locking cap will be placed at the top of the casing and the cap will be water-tight. The section of casing that sticks up above ground will be protected by a steel protective pipe, set at least two-feet deep into a concrete surface seal. A concrete pad should be constructed around the protective steel pipe. The pad should be square, approximately 1.5-by-1.5 feet to two-by-two feet, sloped slightly away from the well, and the top of the pad should be approximately four inches off the ground. The top of the protective pipe will have a vented lockable cap. Protective steel posts will be installed in areas where the well could be struck by vehicles or heavy equipment. Also, a "weep" hole should be drilled in the bottom of the protective steel pipe. In areas where freezing may occur, placement of the weep hole is critical; little volume should exist in the protective casing above the weep hole where water could accumulate and freeze thereby damaging the well. A "V" notch or other permanent mark will be placed at the north edge of the top of the well casing that will be used as the reference point for well elevation surveying and water level monitoring.

Ground or Grade Surface Well Head Completion

Well casing may terminate at the ground surface with a flush-mounted traffic-rated road box. Road box installations must use a water-tight well cap for the well riser pipe in addition to a water-tight road box to prevent surface water from entering the well. The well casing should extend approximately three inches above the sealant in the bottom of the well box. The traffic-rated road box and surface concrete completion should meet Class A specifications, which meet a minimum 4000-pound compressive strength. The surface completion should provide positive drainage away from the well box to prevent ponding around the well. In traffic areas and sidewalks, this positive drainage slope away from the box should be minimized to prevent physical hazards. The surface seal around the box should be a minimum of 12 inches around the perimeter of the box. As discussed above, a reference mark should be placed on the top of the well casing for well elevation surveying and water level monitoring.

Well Location and Surveying

Wells will be located by parcel coordinates required by local permit requirements. Each well will be surveyed by a licensed surveyor in the state where the well has been installed and tied to an established state or county benchmark, site conditions permitting. The vertical survey will be accurate to 0.01 foot relative to mean sea level. Both the top of casing and ground surface elevation near the well will be surveyed for vertical control. The "V" notch cut on the north side of each well casing will be used as the surveyor's reference mark. For horizontal control, each well will be tied to an existing site coordinate system and will be surveyed to a horizontal accuracy of 0.1 foot.

Well Development

Well development is necessary to ensure that complete hydraulic connection is made and maintained between the well and the aquifer material surrounding the well screen and filter pack. The appropriate development method will be selected for each project based on the lithology, objectives, and requirements of that project.

Project-specific planning documents will identify the specific development method to be used. In general, most wells will be developed by using surge block and bailing methods to draw the coarse and/or fine material out of the sand pack. Other development methods that may be used include jetting, airlift, and submersible pump methods. These methods are discussed further below. Jetting is typically not used as a development method for environmental investigations, but is commonly used for water resource monitoring wells or production wells.

Well development should begin no sooner than 48 hours after well installation, if the well annulus is cemented. However, if drilling muds are used during well installation, well development should occur less than 24 hours following well installation so that the drilling mud does not set up in the well screen section.

Generally, a phased process is used to develop wells, starting with a gentle bailing phase to remove sand, followed by a surging phase then a pumping or air lifting phase after the well begins to clear up. The following paragraphs provide more detailed information.

After a well is first installed, and in fact, often before the bentonite pellet seal is set, gentle bailing is used to remove water and sand from the well. The purpose of this technique is to settle the sand pack. After further well sealant materials have been added and allowed to set for approximately 48 hours, bailing is resumed as part of well development. The purpose of bailing is to remove any fine material that may have accumulated in the well, and start pulling in natural material into the sand pack. Bailing is often conducted until the sand content in the removed water begins to decrease.

After the sand content begins to decrease, surging is conducted. A surge block is used to move sediments from the filter pack into the well casing. A surge block consists of a rubber (or leather) and metal plunger attached to a rod or pipe of sufficient length to reach the bottom of the well. All surge blocks will be constructed of materials that will not introduce contamination into the well. Surge blocks should have some manner of allowing pressure release to prevent casing collapse. The surge block is moved up and down the well screen interval and then removed, followed by a return to bailing to remove any sand brought into the well by the surging action. Care should be taken to not surge too strongly with subsequent casing deformation or collapse; the well screen interval is often the weakest part of a well. Surging should be followed by additional bailing to remove fine materials that may have entered the well during the surging effort.

After surging has been completed and the sand content of the bailed water has decreased, a submersible pump is used to continue well development. The pump should be moved up and down the well screen interval until the obtained water is relatively clear. Well development will continue until the water in the well clarifies and monitoring parameters such as pH, specific conductivity, and temperature stabilize as defined in the project-specific planning documents. It should be noted that where very fine-grained formations are opposite the screened interval, continued well development until clear water is obtained might be impossible. Decisions regarding when to cease development where silty conditions exist should be made between the field supervisor and PM.

During well development pH, specific conductivity, temperature, and turbidity should be monitored frequently to establish natural conditions and evaluate whether the well has been completely developed. The main criteria for well development is clear water (Nephelometric turbidity units or NTU of less than 5). As mentioned above, clear water can often be impossible to obtain with environmental monitoring wells. A further criteria for completed well development is that the other water quality parameters mentioned above stabilize to within 10% between readings over three well volumes.

The minimum volume of water purged from the well during development will be approximately a minimum of three borehole volumes (wells will typically not reach stabilization of water quality parameters before this condition is achieved and may not have reached stability even after this threshold has been achieved). The above is a general guideline for difficult well development - project-specific planning documents should address project constraints on well development. Development water will be temporarily stored in 55-gallon Department of Transportation (DOT)-approved drums, tanks or ground pits depending upon the total volume of purge water removed from the newly installed wells, if the location exceeds the site standards. Well development water can be discharged to unlined pits if the well is completed in an area where site standards in the completion interval are not exceeded.

Disposal and Decontamination

All drill cuttings and fluids generated during well installation and development will be containerized pending analytical results and determination of disposal options, as site conditions determine unless project-specific requirements specify otherwise. Waste containment and disposal will occur in a manner that will not result in contamination of the immediate area or result in a hazard to individuals who may come in contact with these materials. For borings drilled in specific areas the following disposal procedures apply;

LTP – All drill cuttings are to be left in the drill cuttings disposal pits and a 1-foot thick layer of clean (non-contaminated) soil placed on top. The area of the pit(s) must be physically inspected occasionally after covered to ascertain if settlement has occurred. If so, additional clean soil must be applied.

Off-Site Areas – Groundwater contamination has only potentially impacted the saturated alluvial and bedrock aquifers. Therefore, non-saturated alluvial materials can be disposed of on the land surface. All potentially contaminated alluvial and bedrock aquifer material shall be disposed of in Evaporation Pond No. 1 (EP-1) which will be the final disposal cell for all licensed 11.e (2) material on the Grants site. The material of aquifers that are not impacted can be disposed in a pit adjacent to the drill site. This includes the Chinle shale which is not impacted due to its very small permeability restricting the movement of contaminants in the shale.

On-Site Areas – Groundwater contamination has only potentially impacted the saturated alluvial and bedrock aquifers. Therefore, non-saturated alluvial materials can be disposed of on the land surface or remain in any such drilling cuttings pits that were constructed. All potentially contaminated alluvial and bedrock aquifer material shall be disposed of in EP-1. The material of aquifers that are not impacted and Chinle shale can be disposed in a pit adjacent to the drill site.

Clean non-contaminated water, such as from the San Andres-Glorieta Aquifer, will be allowed to drain naturally on the ground surface as long as there is *no danger of it draining to a surface water* body or *otherwise directed by regulatory authorities*. Contaminated water or fluids will be disposed of in EP-1.

All drilling and well construction equipment that comes into contact with the borehole will be decontaminated by following the Equipment Decontamination SOP-25.

QUALITY ASSURANCE/QUALITY CONTROL

Borehole drilling and well construction details will be documented in detail in the field. Field documentation forms will consist of a lithologic borehole log, a well construction log, and daily field note forms. Deviations from project-specific planning documents will be documented and explained in daily field notes. The program manager will be contacted to discuss project deviations.

Field quality control can be maintained through 1) making sure employees are properly trained to conduct the work being implemented, and 2) performing routine field audits to evaluate how well employees are following procedures. These two aspects of quality assurance/quality control (QA/QC) are detailed in the Quality Assurance Program documentation.

RECORDS

Field notes and logs will be submitted to the Project Manager or designee immediately following the field event for checking and revision purposes. The Project Manager or designee shall review and transmit the completed forms for incorporation into the project file.

REFERENCES

American Society for Testing Materials (ASTM) A-53-93A or B, A-589-93, or American Petroleum Institute 5L, March 1982 Edition

ASTM Standard F480-94 and the National Sanitation Foundation (NSF) International Standard Number 14-1990, Plastic Piping System Components and Related Materials

Driscoll, F.G., 1986, Groundwater and Wells, Second Edition, Johnson Filtration Systems, Inc., St. Paul, MN

Title 19, Chapter 27, Part 4 Natural Resource and Wildlife, Underground Water, Well Driller Licensing; Construction, Repair and Plugging of Wells (19.27.4 NMAC)

United States Environmental Protection Agency, 1989, Handbook for Suggested Practices for the Design and Installation of Monitoring Wells, EPA 600/4-89/034, Reprinted by the National Ground Water Association.